

MODIS DATA STUDY TEAM PRESENTATION

April 5, 1991

AGENDA

1. Action Items
2. Land Science Proposals, Phase I: Strahler
3. Ocean Science Proposals, Phase I: Clark
4. MODIS Level-1B Processing System Issues

ACTION ITEMS:

03/15/91 [Watson Gregg]: Revise title and date of anchor point accuracies report and deliver to Daesoo Han and Wayne Esaias. STATUS: Delivered to Wayne Esaias 04/03/91. Delivered to Daesoo han 04/05/91.

03/15/91 [Team]: Delete the requirement to append Instrument Status Information from Level-1A Processing System. STATUS: Revised Level-1A Processing System Report delivered 03/22/91. Further revision is required to eliminate status checking. Open.

03/22/91 [Team]: Organize a meeting with Yun-Chi Lu's group to coordinate efforts on categorizing product lists for MODIS. STATUS: Open.

**MODIS Team Member Proposal
Data Requirements Form**

Investigator: Strahler

Output Product(s): 1. Land Cover

2. Land Cover Change

Resolution (Time): 1. monthly and quarterly

2. quarterly only

(Space): 1 km (+/-20%), 5- or 10-km (+/-5% or 10%)

Domain (Space): may be continental or large subregional

At/Post-Launch: Post Launch

MODIS-N/T: N

Input Data: Level-1, -2, and perhaps -3 products that may range from NDVI-type measurements to primary productivity values.

Spectral Bands Required: multiple - 8? (expected to change during post-launch period.)

Resolution (Time):

(Space): probably 1 km (may be 5- or 10-km)

Ancillary Data Required (Type and Source):

Pre-Launch:

AVHRR-LAC, TM, SPOT, aircraft, etc.,
models and ground measurements
for simulated MODIS data (for
algorithm development and
validation).

Digital terrain data.

Size (Mbytes):

20 100 x 100 km
study sites

Post-Launch:

Land Cover Database (including
at-satellite radiances, composited
NDVI, land surface temperature, etc.)
HIRIS and MISR for the above test sites
(for algorithm validation).

Size (Mbytes):

22,000

Algorithm Complexity (floating point operations/scan): 2.5 MFLOPS to process the Land Cover Database.

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan): Each product - 200 Mbytes at 1-km resolution assuming single-byte data (if fullword, will be quadrupled). If 5- or 10-km resolution, 64 and 16 Mbytes, respectively.

For Land Cover Change, many points will be "no change" - some form of data compression would be desirable.

Look-Up Tables Required: Digital Terrain Model

Size (Mbytes):

Lines of Code:

Language Expected:

Accessory Output Products (e.g., field experiment data):

Pre-Launch:

Size (Mbytes):

Post-Launch:

Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

**MODIS Team Member Proposal
Data Requirements Form**

Investigator: Strahler

Output Product(s): 1. Directional Reflectance
2. BRDF
(Both are anticipated to be special-order products)

Resolution (Time): 1. 16 day repeat cycle

(Space): \approx 1 km

Domain (Space): \approx 8 test sites, each 100 x 100 km

At/Post-Launch: 1. At Launch
2. Post Launch

MODIS-N/T: T

Input Data: Atmospherically-corrected, geometrically rectified directional reflectances

Spectral Bands Required: 1. All 32
2. One or a few bands

Resolution (Time):

(Space): 1. 1 km

Ancillary Data Required (Type and Source):

Pre-Launch:
2. PARABOLA, ASAS data

Size (Mbytes):

Post-Launch:
Digital Terrain Model at finer than
1 km resolution

Size (Mbytes):

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

1. 220 MB per product (includes all 32 bands); there are 52 products in 16 days, or about 12 GB.

2. Each 180km by 180km BRDF segment would require about 6 MB per band. If the BRDF segments are assembled in groups of 8, a single band product would be about 50 MB.

Look-Up Tables Required: Digital Terrain Model at finer than 1 km resolution

Size (Mbytes):

Lines of Code:

Language Expected:

Accessory Output Products (e.g., field experiment data):

Pre-Launch:

Size (Mbytes):

Post-Launch:

Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required: may have up to 59 different tilts (stare mode), but the usual mode would be 11 tilt positions

**MODIS Team Member Proposal
Data Requirements Form**

Investigator: Strahler

Output Product(s): Hemispherical Albedo (with Muller)
Resolution (Time):

(Space):

Domain (Space): global or regional

At/Post-Launch: At Launch

MODIS-N/T: T

Input Data: Atmospherically-corrected, gemometrically rectified directional reflectance measurements in a more-or-less fixed geometry with respect to the sun.

Spectral Bands Required: All 32 bands

Resolution (Time):

(Space):

Ancillary Data Required (Type and Source):

Pre-Launch:

Size (Mbytes):

Post-Launch:

Size (Mbytes):

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan): 26 MB per half orbit (assuming 8-bit precision).

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected:

Accessory Output Products (e.g., field experiment data):

Pre-Launch:

Size (Mbytes):

Post-Launch:

Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required: Those required to maintain a more-or-less consistent geometry with respect to the sun.

**MODIS Team Member Proposal
Data Requirements Form**

Investigator: Strahler (and Justice)

Output Product(s): Spatial Structure (Spatial Heterogeneity)
(with Barker)

Resolution (Time): 1 day

(Space): 856 m (1 km)

Domain (Space): global

At/Post-Launch: At

MODIS-N/T: N

Input Data: Level-1B radiances (calibrated)

Spectral Bands Required:

Resolution (Time):

(Space): 214 m

Ancillary Data Required (Type and Source):

Pre-Launch:

Size (Mbytes):

Post-Launch:

Size (Mbytes):

SPOT (10 and 20 m),
TM and HIRIS (30 m),
MOS-1 (50 m),
MSS (80 m), and
MISR (240 m and 1.9 km) data

Algorithm Complexity (floating point operations/scan):

Algorithm Memory Required (Mbytes):

Data Storage Required (Mbytes/scan):

Look-Up Tables Required:

Size (Mbytes):

Lines of Code:

Language Expected:

Accessory Output Products (e.g., field experiment data):

Pre-Launch:

Size (Mbytes):

Post-Launch:

Size (Mbytes):

Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments:

Special Tilt Modes Required:

Note: There are several candidates for spatial structure algorithms. These are: 1) variogram and covariograms, 2) spatial autocorrelation/cross-correlation, 3) texture measures, 4) Fourier transforms

Size (Mbytes):

Lines of Code:

Language Expected:

Accessory Output Products (e.g., field experiment data):

Pre-Launch:	Size (Mbytes):
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Post-Launch:	Size (Mbytes):
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Expected Need of SDST (Pre- or Post-Launch):

Post-Launch Expected Growth:

Quality Assessments: One of primary post-launch roles

Special Tilt Modes Required:

Notes: Clark is listed for "primary responsibility" for 14 products/parameters and "contributor" for 4 products/parameters in the ocean team Table 4 (attached). Clark's contribution is mainly directed to the collection and processing of Marine Optical Buoy System (MOBS) data and cruise data for use by MODIS for algorithm development, calibration and validation. His schedule provides for five buoy deployments plus four cal./val. post launch cruises and four quality control cruises. The schedule is given in Figure 2 (attached). Clark estimates the total yearly volume from the at-sea experiments and buoy systems to be at the half gigabyte level during pre-launch and at a gigabyte level throughout post-launch. The MODIS sensor calibration and ocean products validation flow diagrams are shown in Figure 3 (attached).

TABLE 4. MODIS ALGORITHM DEVELOPMENT AND VALIDATION DATA PRODUCTS:

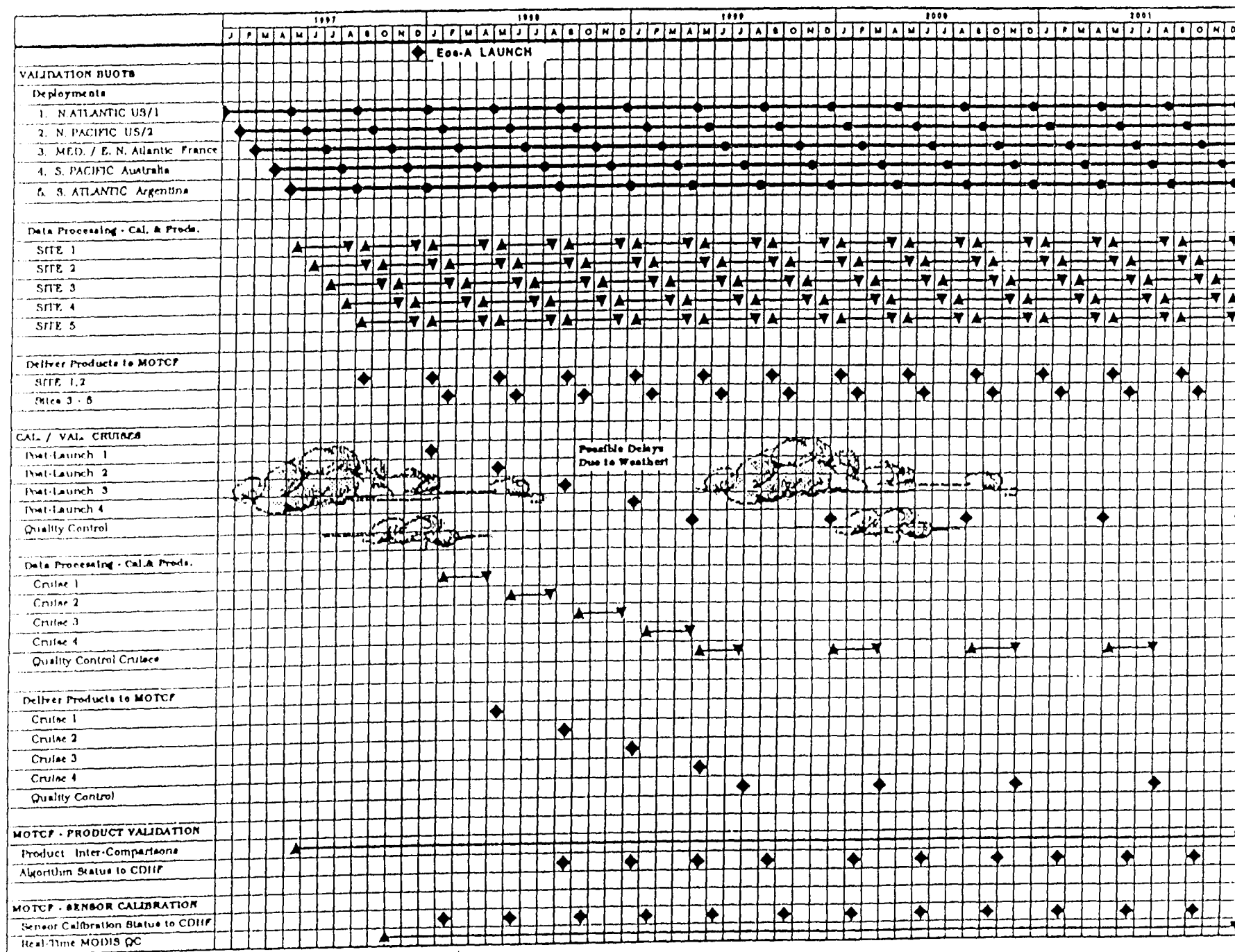
PRODUCT/PARAMETER	TEAM MEMBER									
	MA	IB	OB	KC	DC	WE	FE	FH	HG	JP
			I	II						S.O.
1 Incident Spectral Irradiance-Ed,Z(0,+)	C			C	P	P	C	C		P
2 Downwelled Spectral Irradiance-Ed,Z	C			C	P	P		C		P
3 Upward Spectral Radiance-Lu	C			C	P	P	C	C		P
4 Water-Leaving Spectral Radiances-Lw				C	P	P	C	C		P
5 Spectral Beam Attenuation Coefficients-c	C			C	P	P		C		P
6 Diffus. Atten. Coef. Downwel. Irrad.-KEd				C	P	P		C		P
7 Diffus. Atten. Coef. Upwel. Rad.-KLu				C	P	P		C		P
8 Photosynth. Active Radiat.(400-700nm)	C			C	P	C	C			P
9 Fluoresc. Line Magnit. @685 nm- FLM(z)	C			C	P	P		C	C	
10 Spectral Reflect.(or Radiance Factor)-RL				C	P	P	C	C		P
11 Phyto.Pig(Fluor.Tech.)Chlor.a and Phaeo.a	C			C	P	P		C	C	P
12 Phytoplankton Pigments(HPLC Technique)				C	P	P		C		P
13 Phycobilipigment Concentration				C	P				P	P
14 Total Suspended Matter(TSM) Conc.					P		C			P
15 Organic Suspended Matter Conc.					P		C			P
16 Inorganic Suspended Matter Conc.					P		C			
17 Temperature	C	P	P	C	C		C			C
18 Primary Productivity (14-C)	C			C	P	C	P	C		P
19 Salinity- S	C			C	P					P
20 IR Surface Brightness Temperature		P	P			C	C			C
21 Coccolith Concentration									P	
22 Humic and Fulvic Acid concentration				C	P			C		
23 Particle absorption coefficient				C	P					P
24 Detritus absorption coefficient				C	P					P
25 Scattering coefficients (b, bb, etc.)				C	P				P	P
26 Total Dissolved Organic Carbon				C	P					P
27 Spectral Solar Atmospheric trans. (Ta)				C	P				P	
28 Airborne Fluorescences	C						C		P	
29 Airborne Radiances	C						C		P	P
30 Sky Radiance Distribution (spectral)									P	
31 Submerged Up Radiance Distribution									P	
32 Dissolved Colored Organic Material conc.				C	P					P

MA ABBOTT
 IB BARTON
 OB BROWN
 KC CARDER
 DC CLARK
 WE ESAIAS
 FE EVANS
 FH HOGE
 HG GORDON
 JP PARLOW

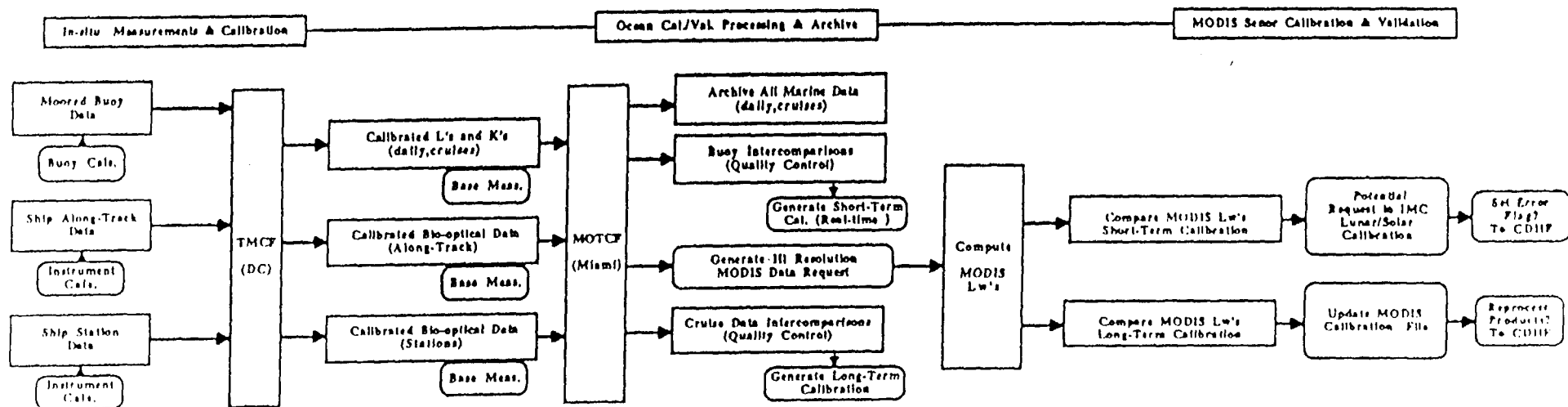
P Primary responsibility
 C Contributor

 I Case I
 II Case
 S.O. Southern Ocean

Figure 2. MODIS PRODUCT and SENSOR VALIDATION / CALIBRATION SCHEDULE



MODIS SENSOR CALIBRATION



MODIS OCEAN PRODUCTS VALIDATION

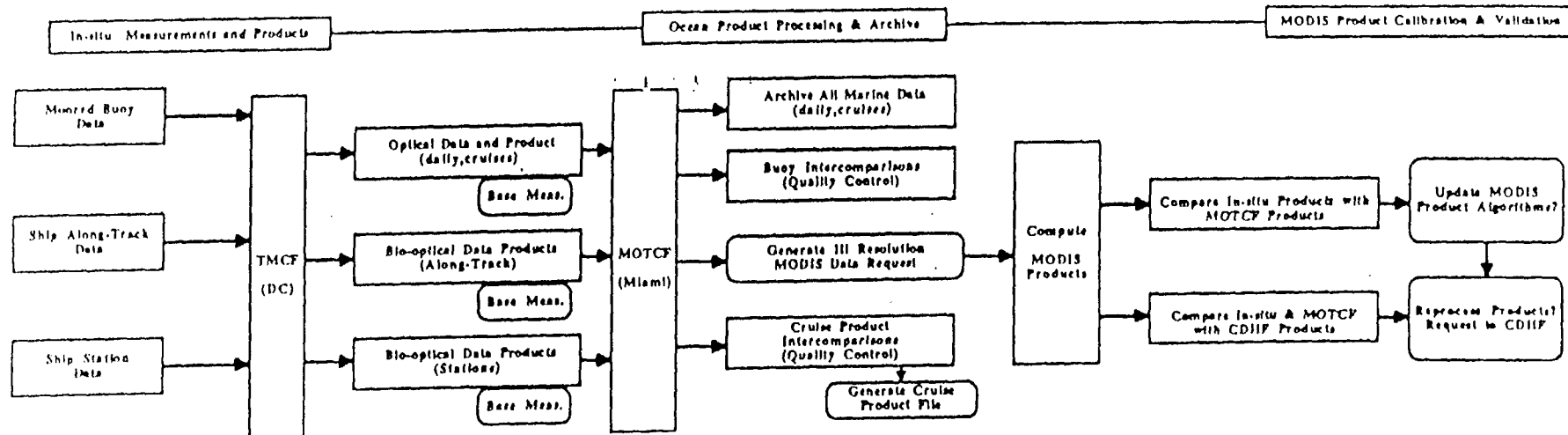


Figure 3

MODIS LEVEL-1B PROCESSING SYSTEM ISSUES

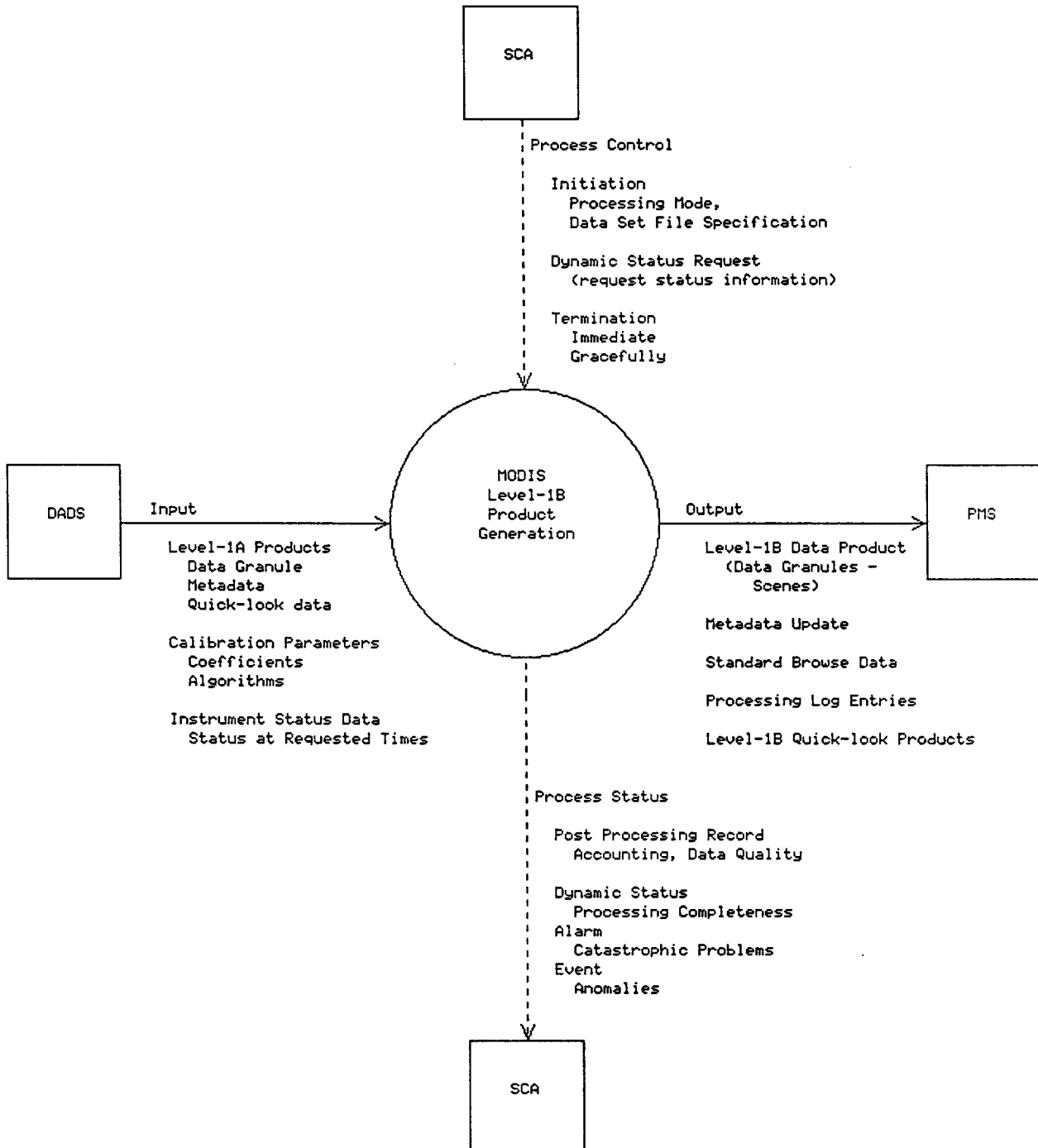
Level-2 processing of MODIS Land Products may be performed at the EROS Data Center (EDC). This will require sending MODIS Level-1B data to EDC. It is desirable to send only land data to minimize transmission costs. Some issues arise here as to handle Level-1B processing to facilitate transfer of land data to EDC. These issues apply also to the NSIDC for ice and snow processing.

1. If only land data are sent, the data must first be flagged. Should the flagging occur in the standard Level-1B processing design or should there be a separate process following the completion of Level-1B?

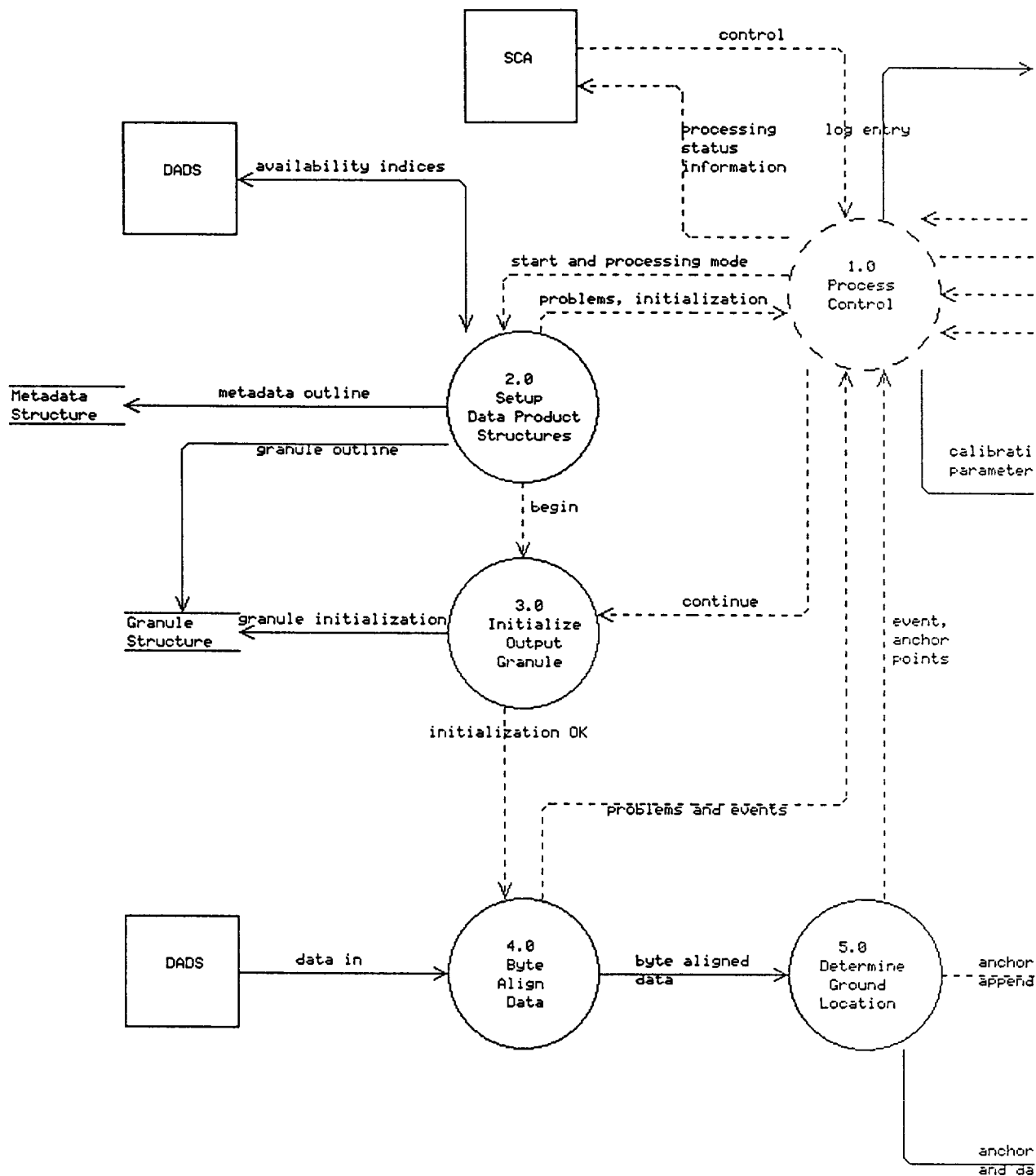
2. Since navigation at Level-1B is done only at anchor points, many radiances will not be navigable. Navigation to each pixel will triple the data volume, resulting in little loss of data from sending all of Level-1B data. What should be sent to EDC?

APPENDIX

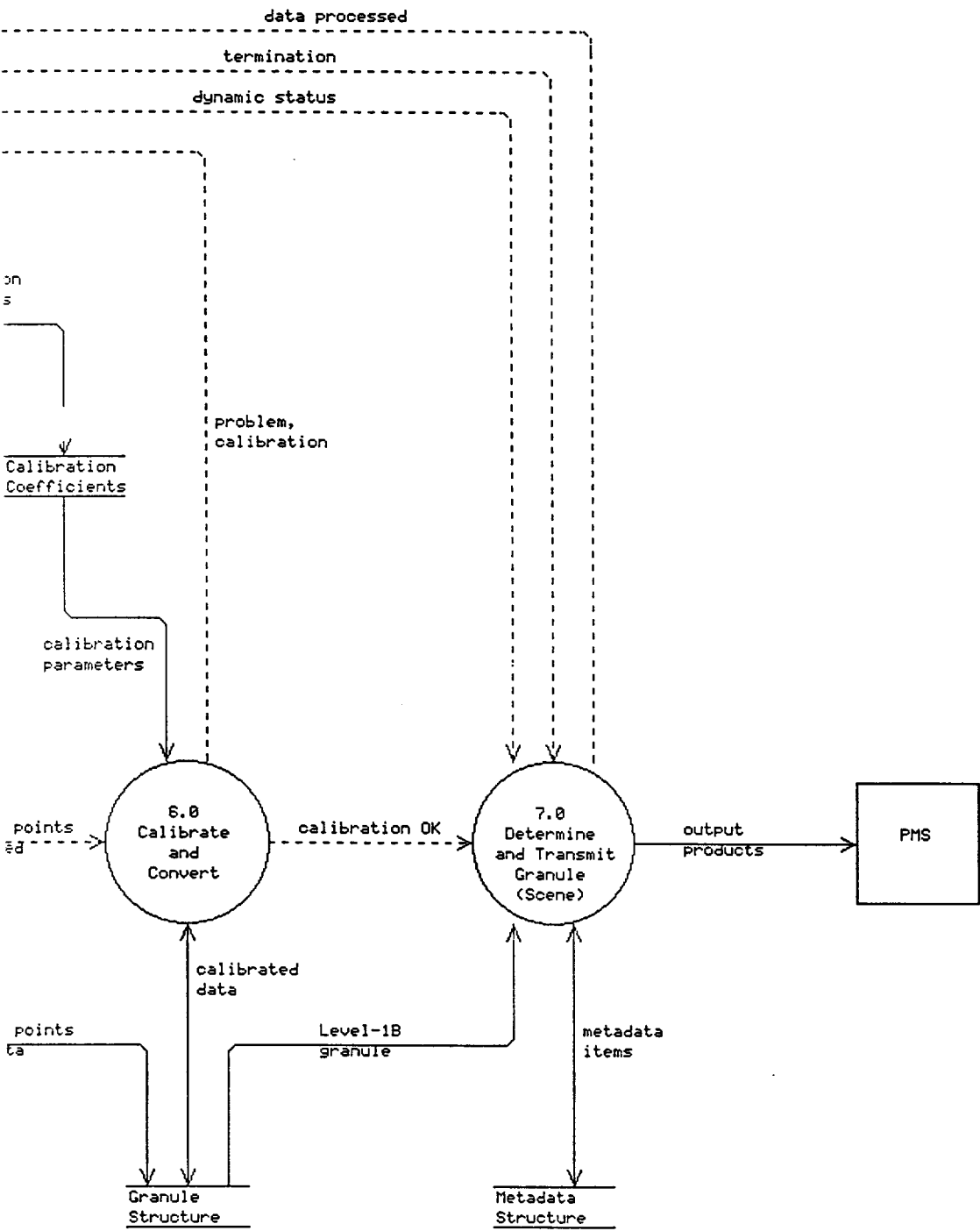
Project : \ECPLUS\MODIS-1B\
Chart : context
Filename : context.trg
Last Modified : 04-02-1991



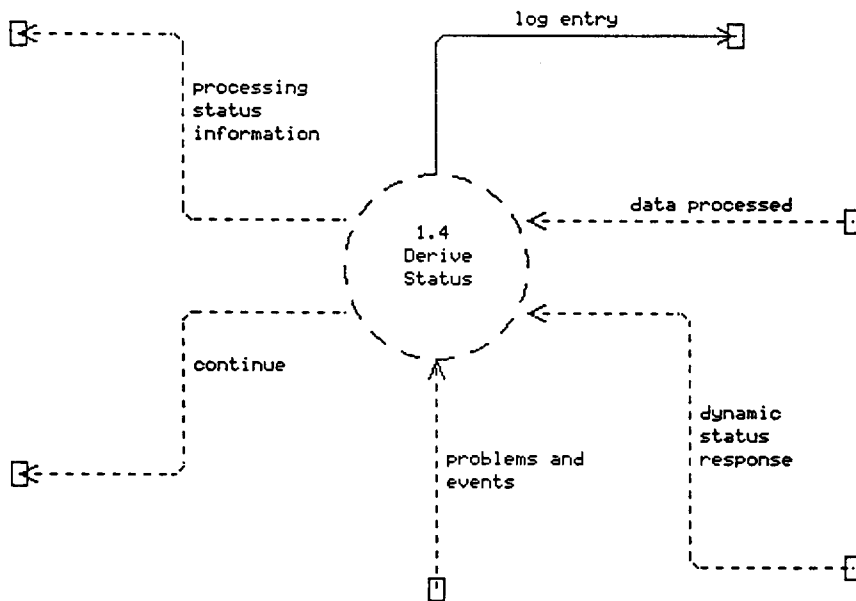
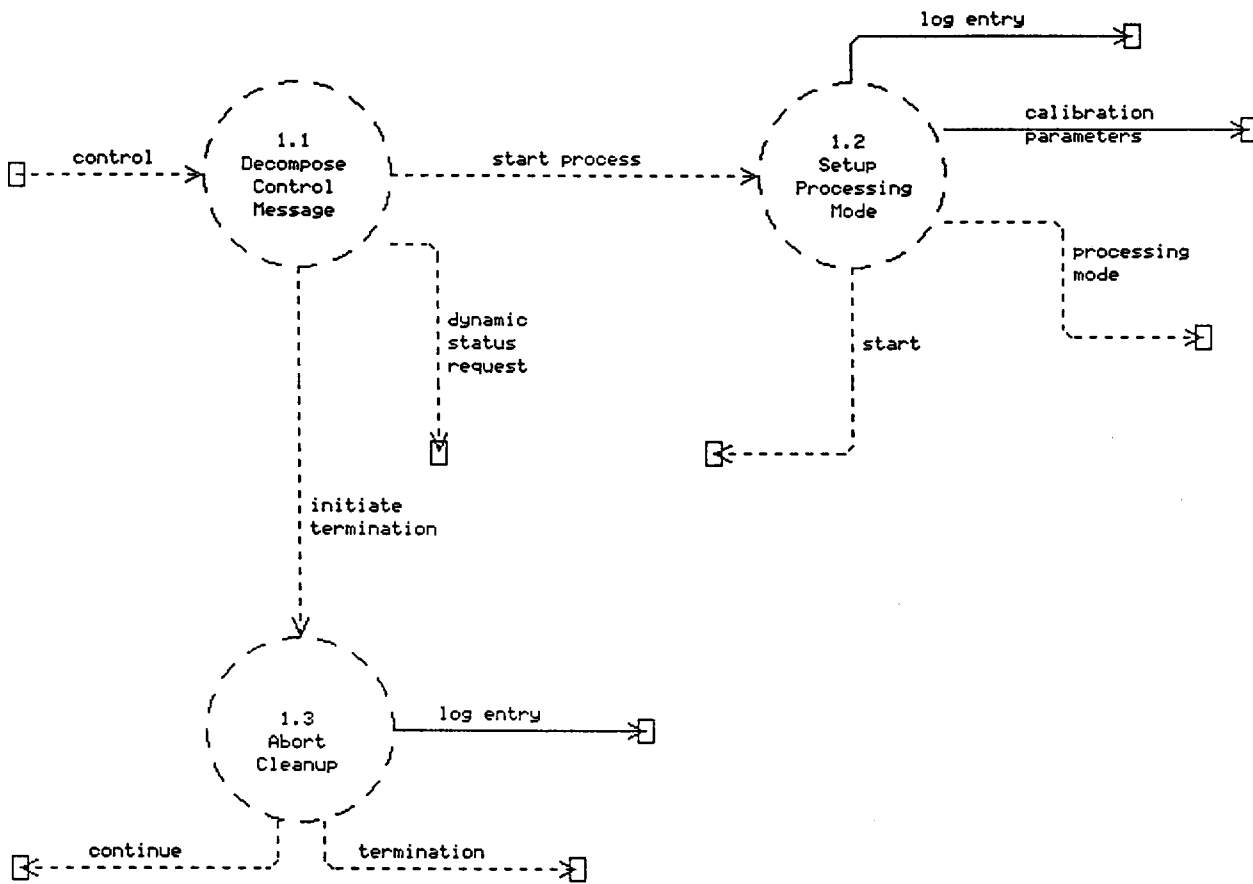
Project : \ECPLUS\MODIS-1B\
 Chart : level-a
 Filename : level-a.trg
 Last Modified : 04-02-1991



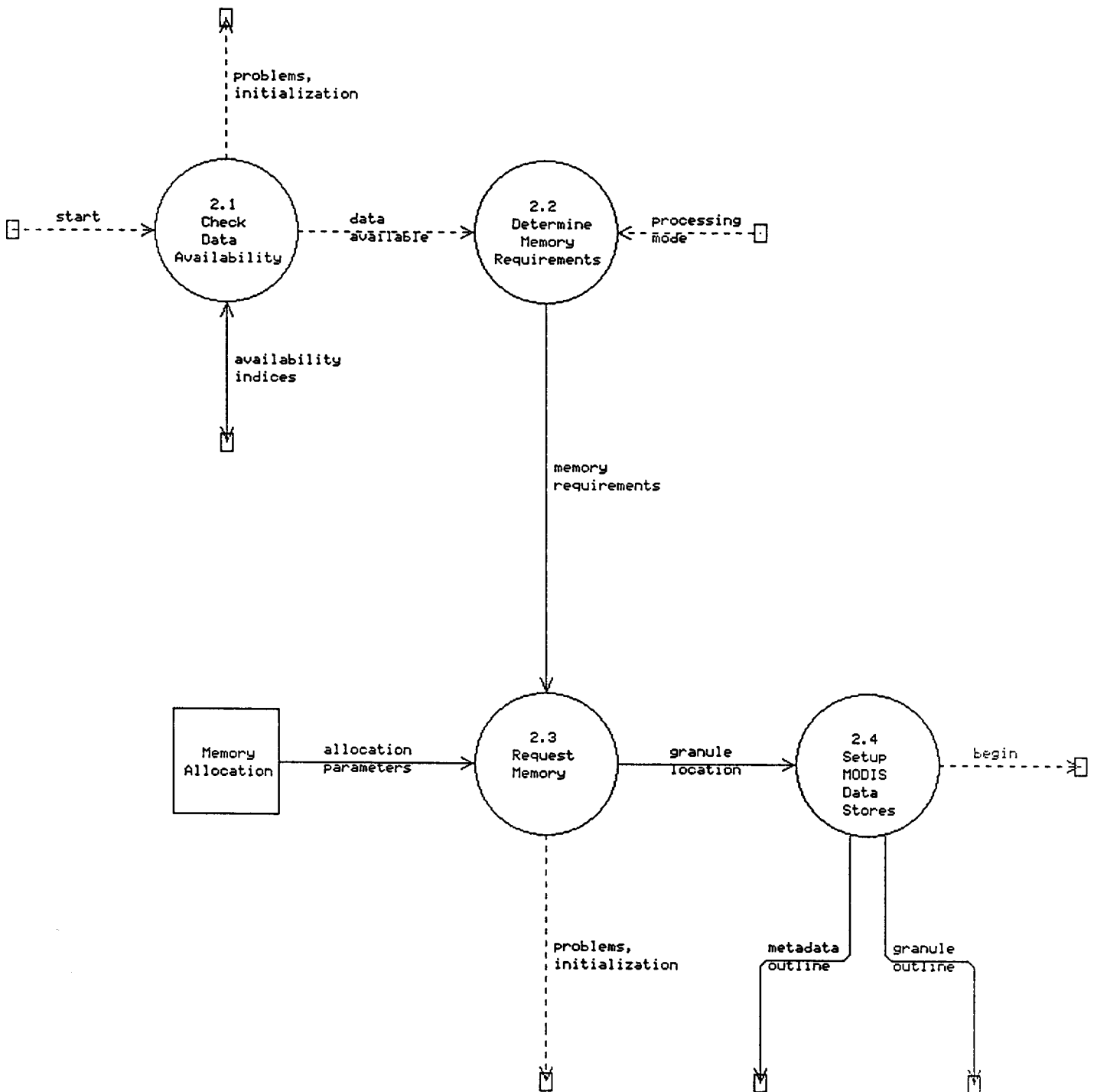
Processing
Log



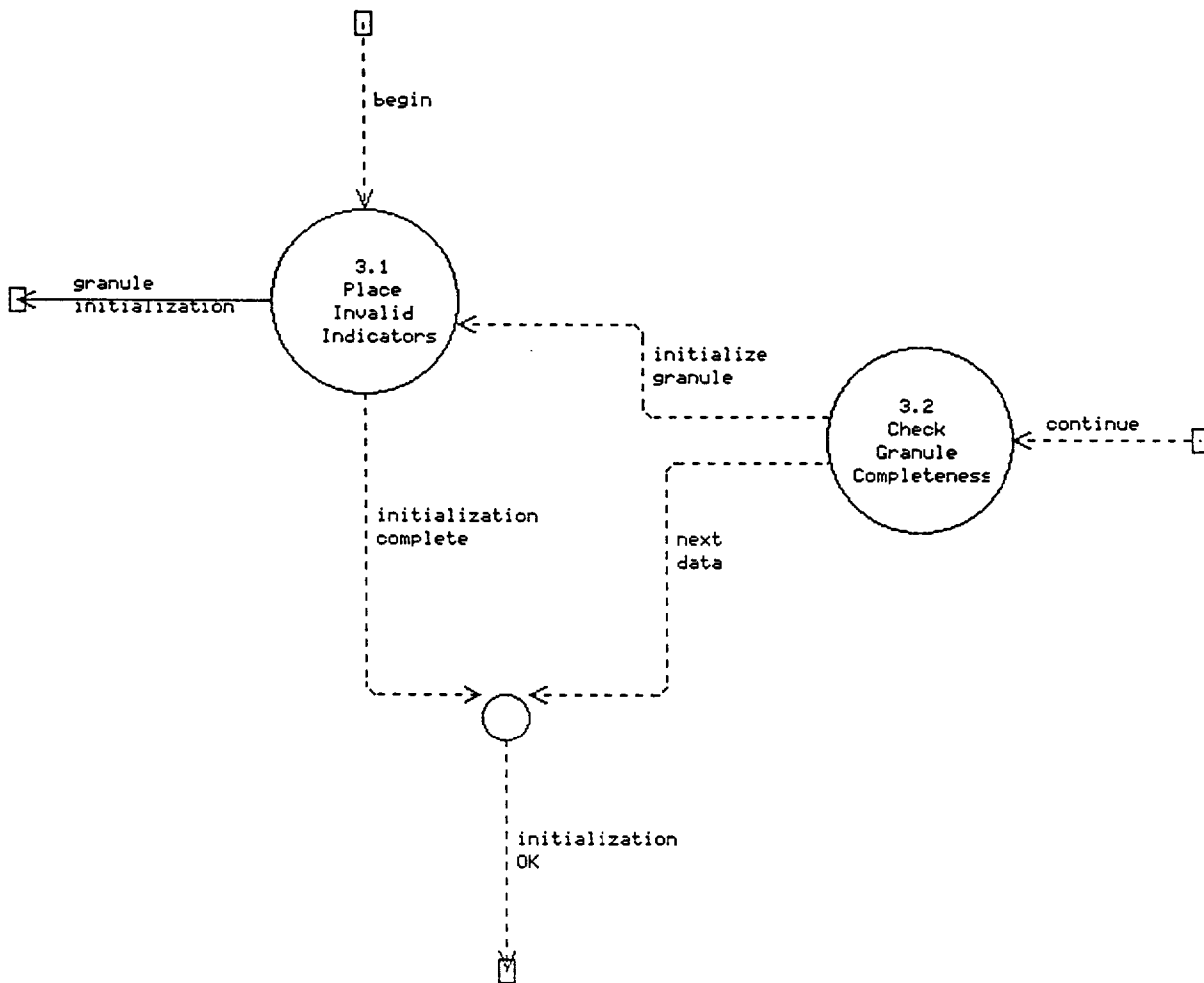
Project : \ECPLUS\MODIS-1B\
Chart : level-b1
Filename : level-b1.trg
Last Modified : 04-02-1991



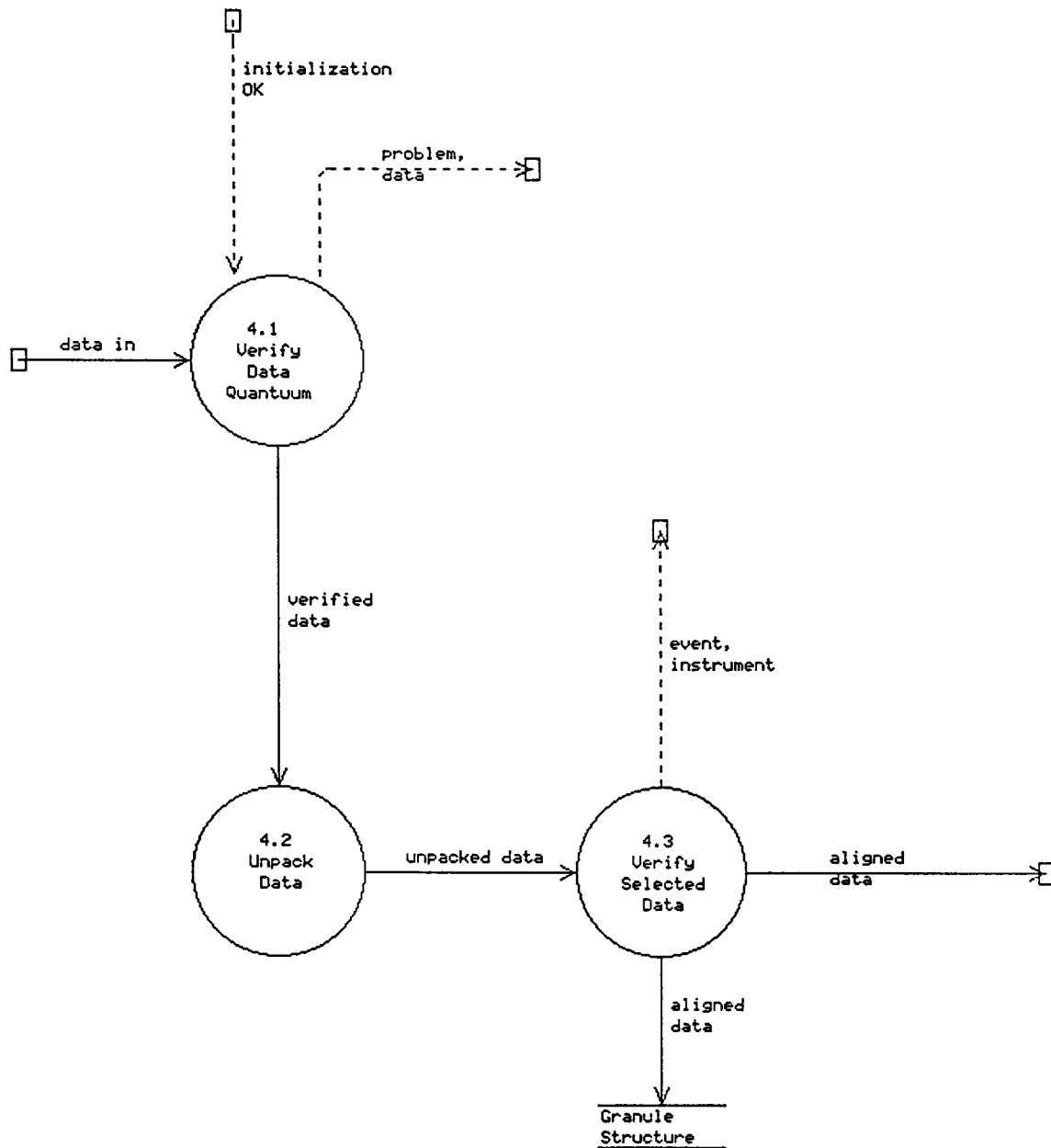
Project : \ECPLUS\MODIS-1B\
Chart : level-b2
Filename : level-b2.trg
Last Modified : 04-02-1991



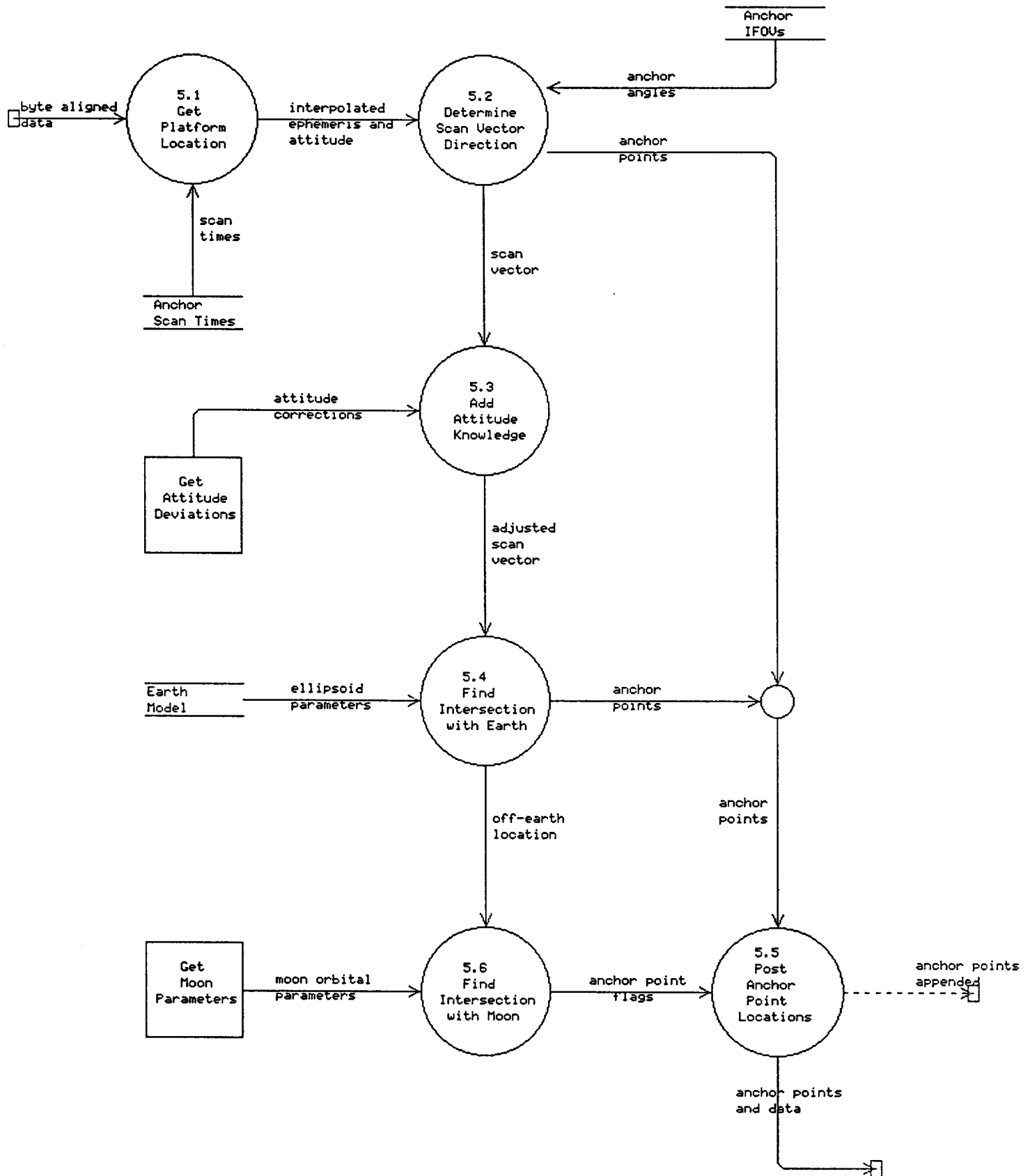
Project : \ECPLUS\MODIS-1B\
Chart : level-b3
Filename : level-b3.trg
Last Modified : 04-02-1991

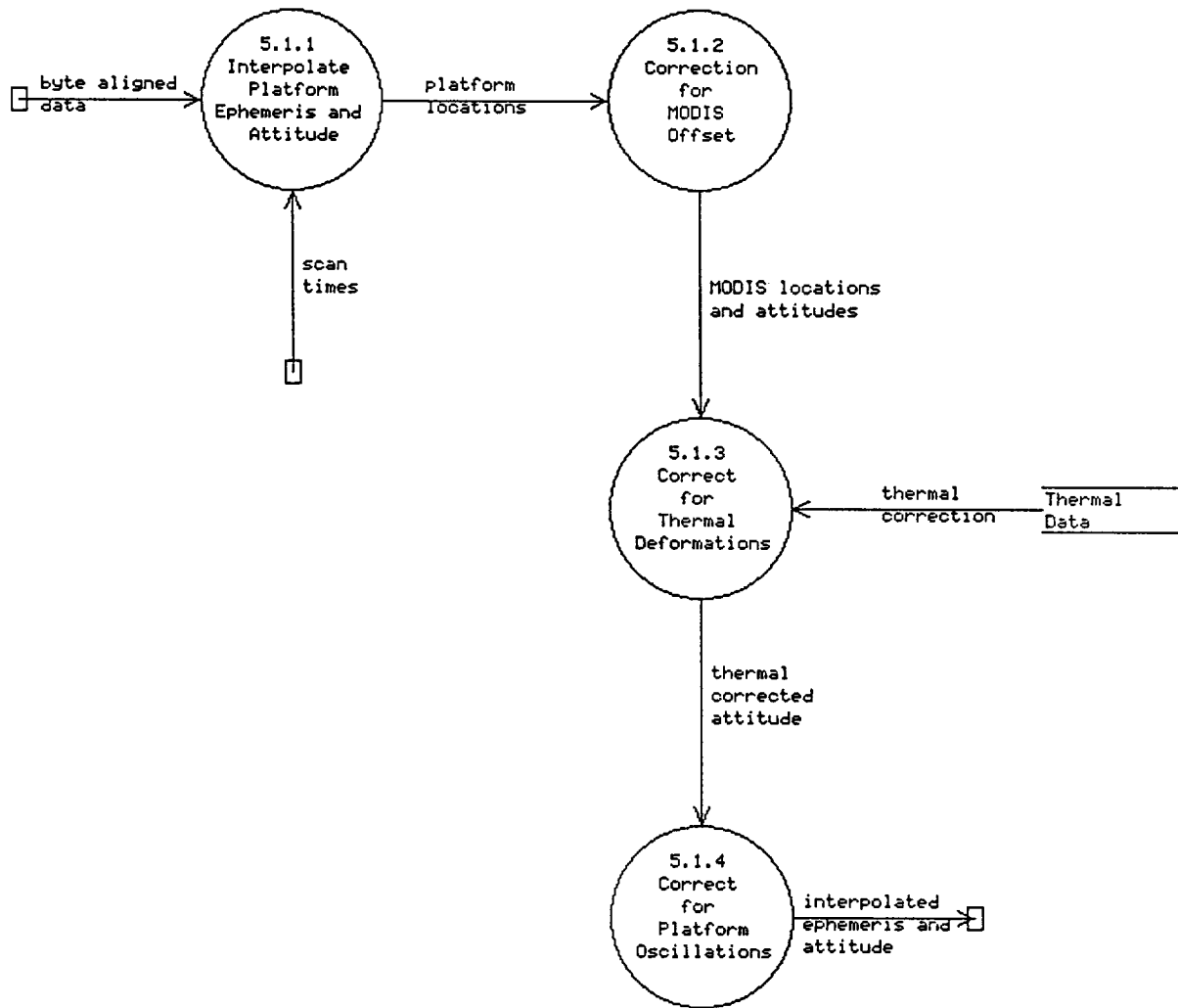


Project : \ECPLUS\MODIS-1B\
Chart : level-b4
Filename : level-b4.trg
Last Modified : 04-02-1991

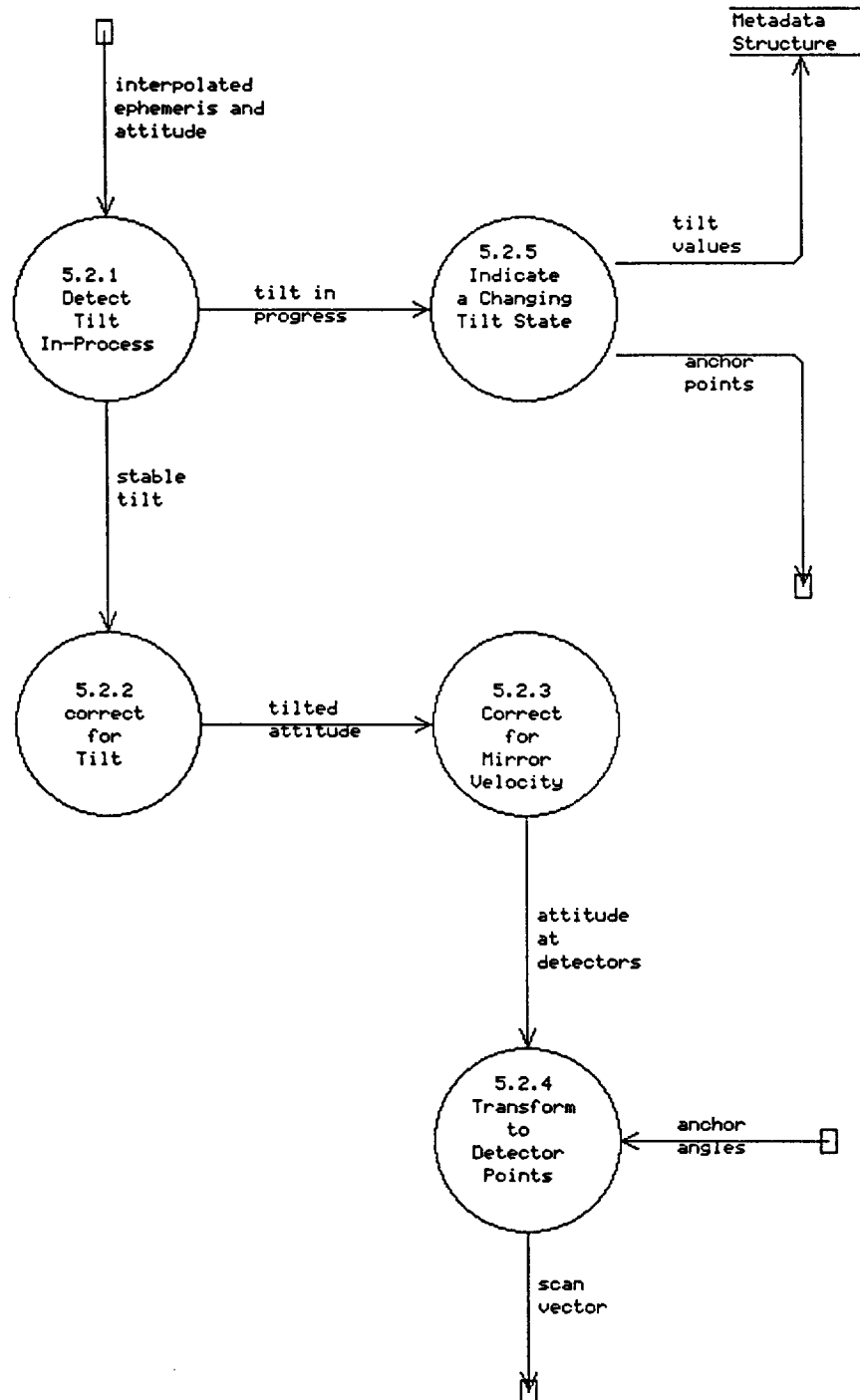


Project : \ECPLUS\MODIS-1B\
 Chart : level-b5
 Filename : level-b5.trg
 Last Modified : 04-02-1991

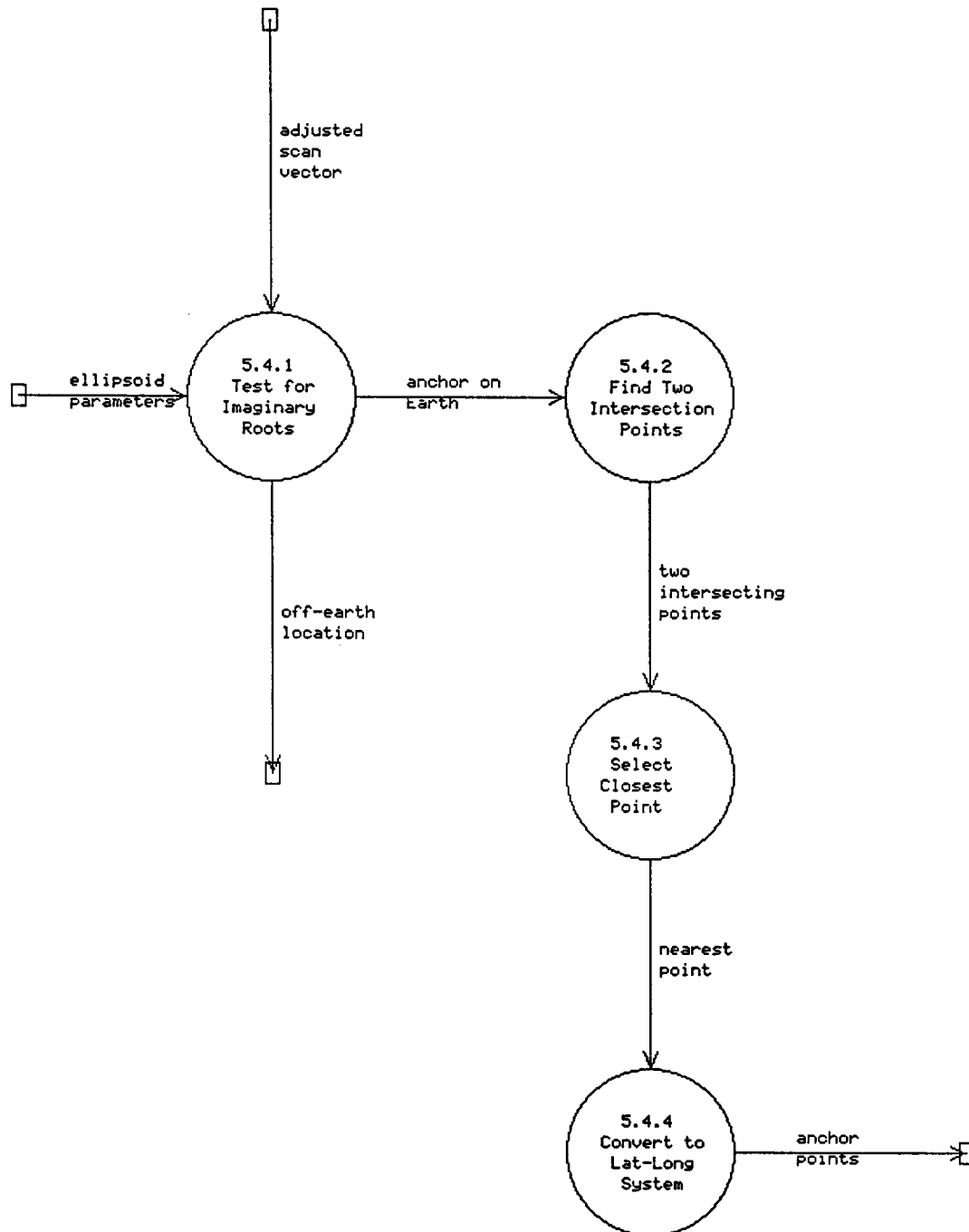


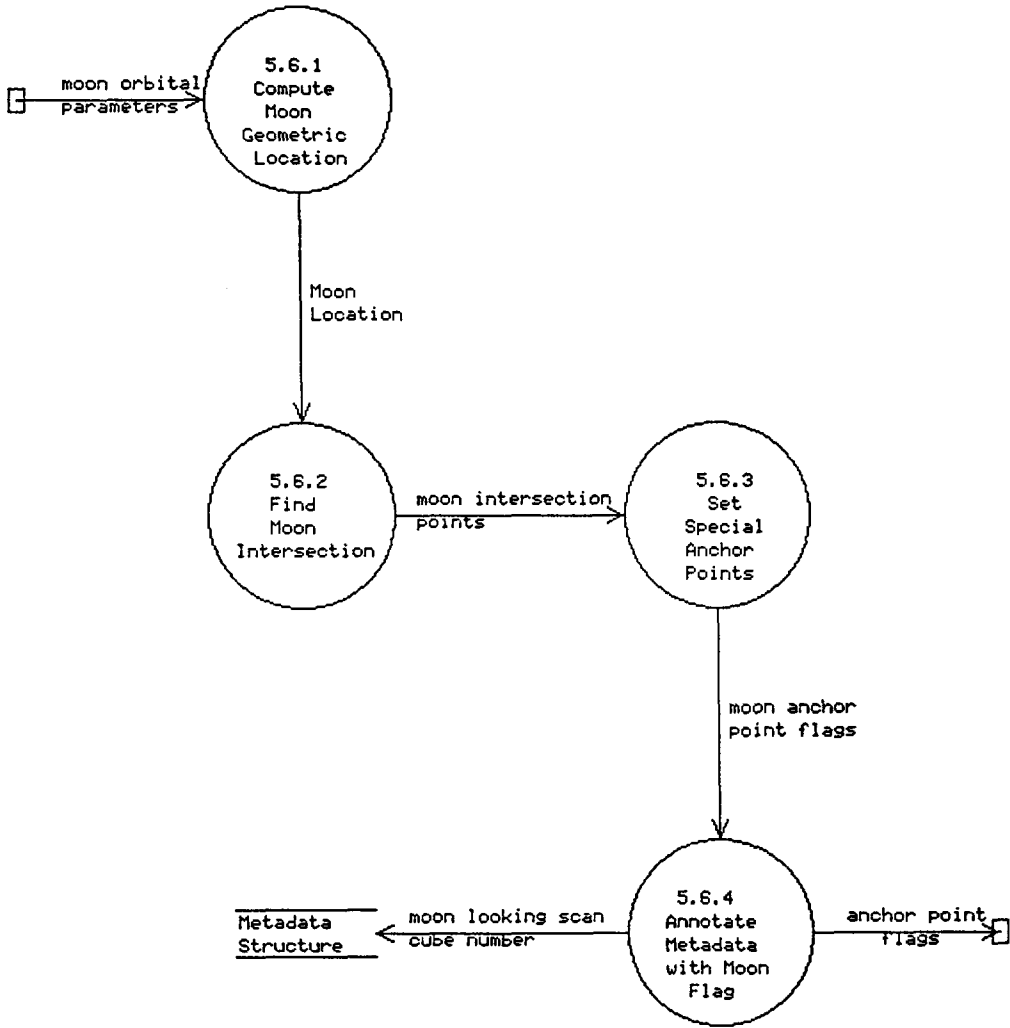


Project : \ECPLUS\MODIS-1B\
Chart : lv1-c52
Filename : lv1-c52.trg
Last Modified : 04-02-1991

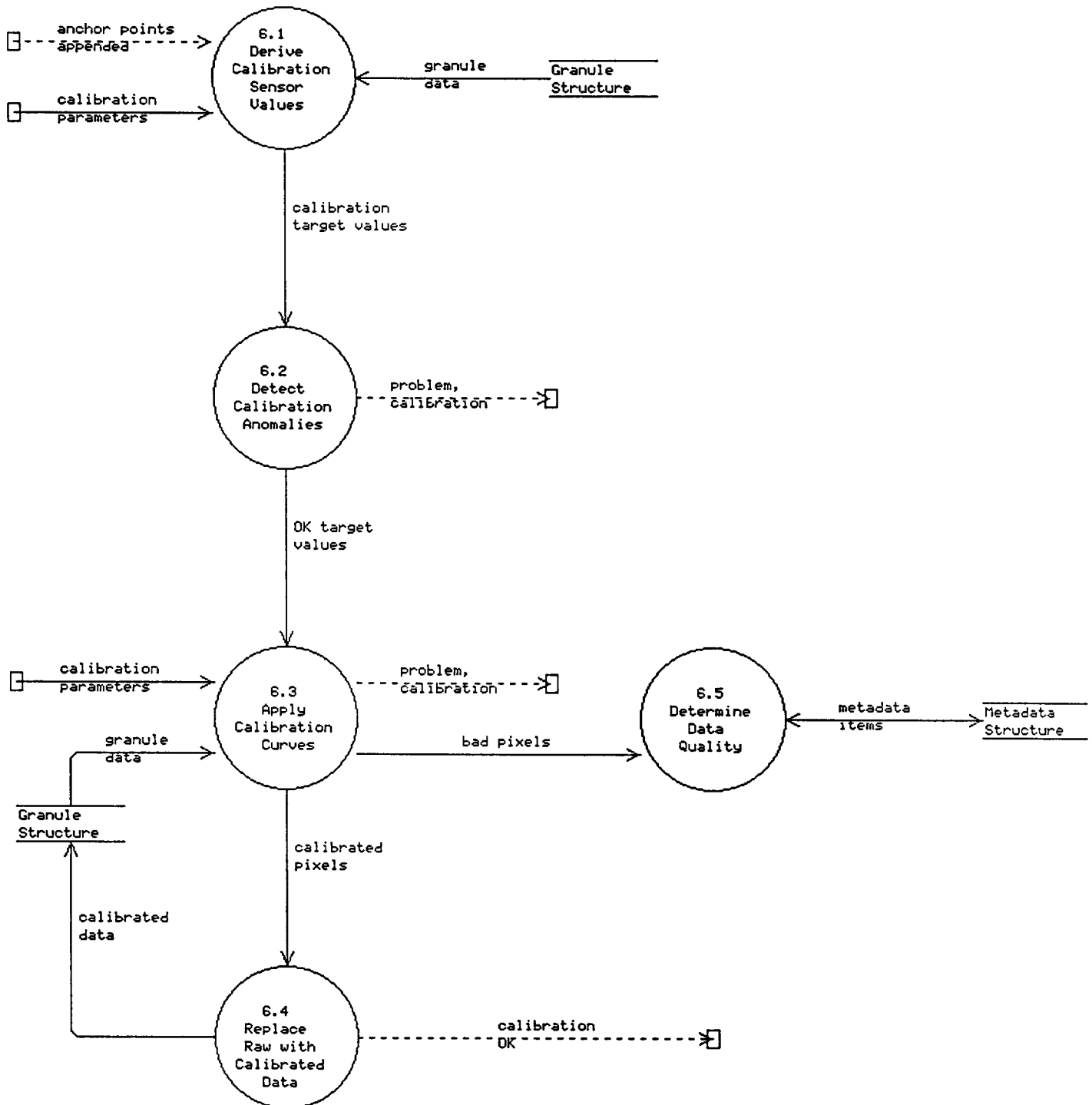


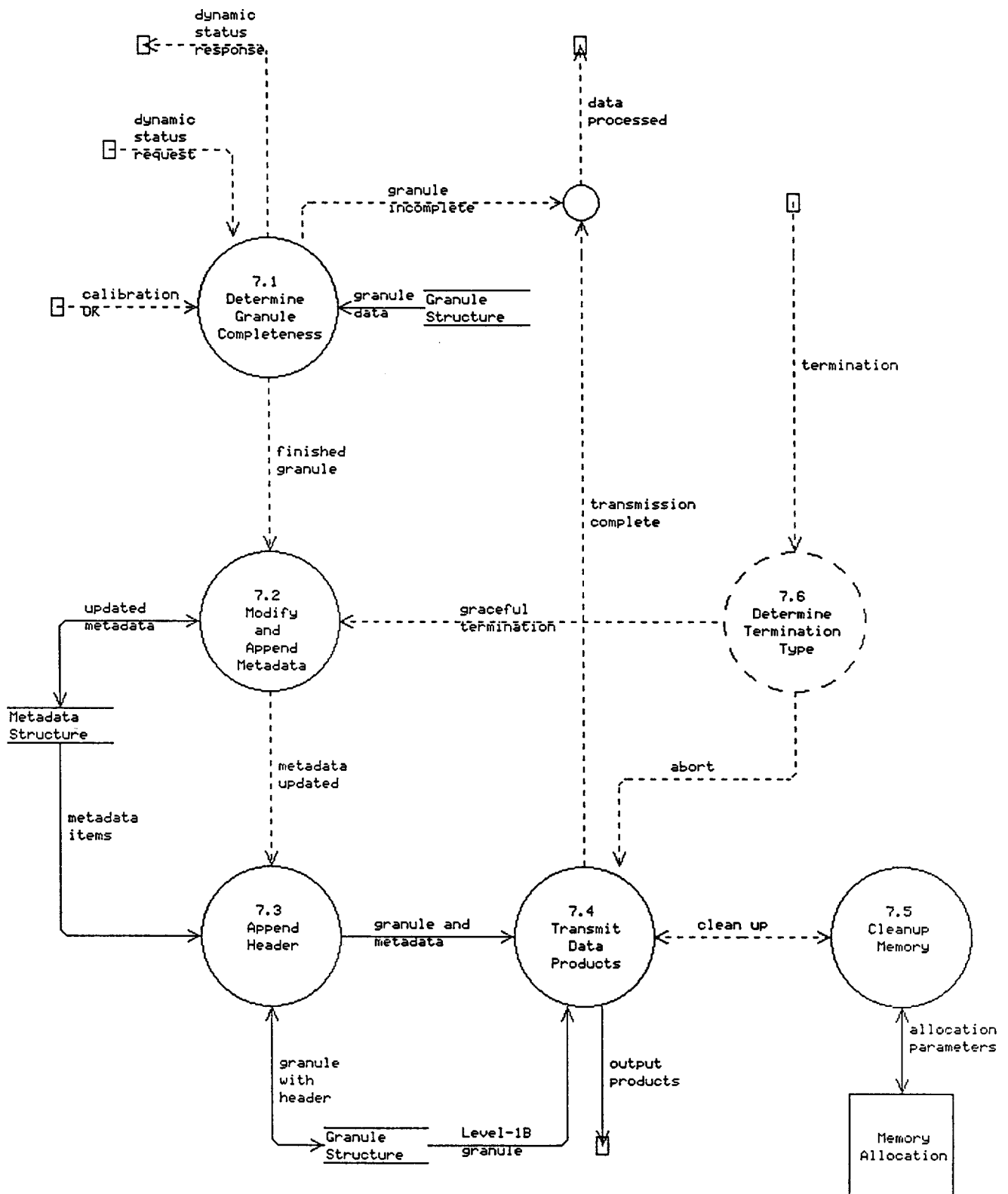
Project : \ECPLUS\MODIS-1B\
Chart : 1v1-c54
Filename : 1v1-c54.trg
Last Modified : 04-02-1991





Project : \ECPLUS\MODIS-1B\
Chart : level-b6
Filename : level-b6.trg
Last Modified : 04-02-1991





Abort

Type: Control Flow

Location: 7.6, 7.4

An indication to perform an immediate abort by releasing system resources (memory and disk space) and posting a termination message to the SCA.

Abort Cleanup

Type: Control Transform

Location: 1.3,

Processes termination messages into the proper flow control items: either a graceful termination (all files written and closed) or abort-now condition (immediate termination without posting files). Posts an entry to the Processing Log.

Add Attitude Knowledge

Type: Data Process

Location: 5.3,

Correct the computed instrument scan vector for any empirically derived anomalies. These may be derived from ground control point convolutions or other techniques and are contained in a periodically updated database. DEM and refraction may be added here.

Adjusted Scan Vector

Type: Data Flow

Location: 5.3, 5.4

The sensor scan vector corrected for any perturbations - derived or observed.

Allocation Parameters

Type: Data Flow

Location: Memory Allocation, 2.3

A request to the operating system for storage allocation and a response with the storage parameters or alternately, an error message.

Anchor Angles

Type: Data Flow

Location: Anchor IFOVs, 5.4

The angular offsets from the instrument nadir vector for each of the anchor points.

Anchor IFOVs

Type: Data Store

Location: 5.2,

A data store containing the scan definitions of the points for which ground anchor locations will be computed.

Anchor on Earth

Type: Data Flow

Location: 5.4.1, 5.4.2

A positive number indicating that the scan vector intersects the Earth.

Anchor Point Flags

Type: Data Flow

Location: 5.6, 5.5

Flags indicating the presence of a scan vector to Moon intersection. Pixel data and scan vector angles may be saved here for calibration and attitude purposes.

Anchor Points

Type: Data Flow

Location: 5.4, 5.5

The location of the ground anchor points in Earth coordinates.

Anchor Points and Data

Type: Data Flow

Location: 5.0, Granule Structure

A quantum of level-1A data, byte aligned and with ground located anchor points appended.

Anchor Points Appended

Type: Control Flow

Location: 5.0, 6.1

An indication that the ground location anchor points have been appended to the granule (scene).

Anchor Scan Times

Type: Data Store

Location: 5.1,

The spacecraft offset times from the reference scan cube time for each of the ground anchor points. This is a function of the instrument scan rates.

Annotate Metadata with Moon Flag

Type: Data Process

Location: 5.6.4,

Update or create a metadata item that indicates the cube number and time of a Moon scan vector intersection.

Append Header

Type: Data Process

Location: 7.3,

Create and append the granule header. This is a superset of the Metadata items.

Apply Calibration Curves

Type: Data Process

Location: 6.3,

For every science pixel, apply the calibration equations taking the gain bit into consideration. Test for inconsistencies and generate SCA reports, invalid flags, and default values.

Attitude at Detectors

Type: Data Flow

Location: 5.2.3, 5.2.4

The scan cube with anchor points that have been corrected for the current location of the scan mirror.

Attitude Corrections

Type: Data Flow

Location: Get Attitude Deviations, 5.3

Small correction angles used to further improve the attitude information.

Availability Indices

Type: Data Flow

Location: 2.1, DADS

An enquiry to and a response from the external database containing a map of the data set sizes and completeness that is used to determine if the MODIS Level-1B processing can be properly performed.

Bad Pixels

Type: Data Flow

Location: 6.3, 6.5

Pixels of data that can not be calibrated properly. This is used for Data Quality Assessment. This function can be expanded to include data validation.

Begin

Type: Control Flow

Location: 2.4, 3.1

An indication to begin processing MODIS data.

Byte Align Data

Type: Data Process

Location: 4.0,

Extract the data from the scan cube and byte/word align it. This places the data into a valid computer data type.

Byte Aligned Data

Type: Data Flow

Location: 4.3, 5.1

MODIS data that has been placed into a valid computer data word type.

Calibrate and Convert

Type: Data Process

Location: 6.0,

Convert the raw counts data to their physical measurements. Science data to albedo or energy values, engineering data to temperatures, positions, rates, etc.

Calibrated Data

Type: Data Flow

Location: 6.4, Granule Structure

The data contained in the granule subset (quantum or scan cube) that is converted from instrument digital counts to the proper science or engineering dimensional units.

Calibrated Pixels

Type: Data Flow

Location: 6.3, 6.4

Science data values that have been calibrated to at instrument radiances.

Calibration Coefficients

Type: Data Store

Location: ,

Parameters used to calibrate both the engineering and the science data from the instrument. This includes any instrument characterization information.

Calibration OK

Type: Control Flow

Location: 6.4, 7.1

An indication that the MODIS data has been calibrated and converted to its final Level-1B format.

Calibration Parameters

Type: Data Flow

Location: 1.2, 6.1 via Calibration Coef

Any data values or algorithms that are used to calibrate the instrument data.

Calibration Target Values

Type: Data Flow

Location: 6.1, 6.2

Data values that may be used to perform calibration on the science pixel values. This may include temperatures or non-Earth pointing data values.

Check Data Availability

Type: Data Process

Location: 2.1,

Perform a verification that the data (MODIS Level-1B granule and Metadata) required to complete the output granule is available to this MODIS Level-1B program.

Check Granule Completeness

Type: Data Process

Location: 3.2,

Determine if the computer output granule store has been posted to disk and enable this store initialization if true.

Clean Up

Type: Control Flow

Location: 7.4, 7.5

An indication to perform the final clean up of data stores, posting a post event record to the SCA via this program's control mechanism.

Cleanup Memory

Type: Data Process

Location: 7.5,

Deallocate the computer memory and disk store areas.

Compute Moon Geometric Location

Type: Data Process

Location: 5.6.1,

Given the orbital parameters of the Moon, calculate the current location of the Moon in the inertial coordinate system. This may be performed with an interpolated table lookup.

Continue

Type: Control Flow

Location: 1.3, 3.2

An indication to continue the processing of MODIS data.

Control

Type: Control Flow

Location: SCA, 1.1

Messages from the EOSDIS scheduler containing start, finish, and requests for dynamic status.

Convert to Lat-Long System

Type: Data Process

Location: 5.4.4,

Convert the nearest scan vector to Earth intersection point from the inertial coordinate system to the latitude longitude coordinate system.

Correct for Mirror Velocity

Type: Data Process

Location: 5.2.3,

Correct the anchor point vectors for any anomalies in the position of the scan mirror as a function of time or mirror position.

Correct for Platform Oscillation

Type: Data Process

Location: 5.1.4,

Correct the MODIS attitude (and position) for oscillations due to other instruments. This requires knowledge of the dynamics of other devices derived from the ancillary data stream attached to the MODIS level-1A data product.

Correct for Terrain Elevation

Type: Data Process

Location: 5.4,

Perform an iterative correction to the Earth - scan vector intersection to correct for Earth terrain elevation. This can be performed as a correction to the Earth radius in the Ellipsoid model. A limited iteration predictor corrector method will be used.

Correct for Thermal Deformations

Type: Data Process

Location: 5.1.3,

Correct the MODIS instrument attitude (and position) for platform thermal deformations. Thermal data is obtained from the telemetry stream and calibrated with thermistor curves.

Correct for Tilt

Type: Data Process

Location: 5.2.2,

Correct the anchor points for the MODIS-T Tilt angle. Account for any instrument tilt settling dynamics.

Correction for Modis Offset

Type: Data Process

Location: ,

Perform a coordinate transformation to correct the platform position and attitude to the MODIS position and attitude.

DADS

Type: External Entity

Location: 2.0, 4.0

Data Archive and Distribution System. The EOSDIS core system program that manages the input and output product databases.

Data Available

Type: Control Flow

Location: 2.1, 2.2

An indication that the data sets required to process the output granule(s) are available from the external database storage. This is expected to be in the form of database indices.

Data In

Type: Data Flow

Location: DADS, 4.1

Level-1A data products generated by the MODIS Level-1A program. This consists of the Level-1A data granule and the Level-1A Metadata.

Data Processed

Type: Control Flow

Location: 7.0, 1.4

An indication that data has been processed and more data is needed. This also indicates the completion of a granule (scene) of data.

Decompose Control Message

Type: Control Transform

Location: 1.1,

Decomposes the incoming message to determine the type of message and where to send it.

Derive Calibration Sensor Values

Type: Data Process

Location: 6.1,

Find quantitative values for calibration known values. This includes in-situ (on Earth), off Earth, and/or on instrument spots. Also included are dark current and per sensor array element corrections.

Derive Status

Type: Control Transform

Location: 1.4,

Handles problem (alarm) and event messages as well as data termination messages, posts entries to the Processing Log, and passes a Post Processing message to the SCA.

Detect Calibration Anomalies

Type: Data Process

Location: 6.2,

Look for inconsistencies in the calibration targets defined in 6.1. Alert the SCA of any problems, assume default conditions, and flag the data as incompletely calibrated.

Detect Tilt In-Process

Type: Data Process

Location: 5.2.1,

Compare the tilt angle before the scan cube with the tilt angle after the scan cube. Ground anchor points can not be determined if the tilt angle is unstable.

Determine and Transmit Granule

Type: Data Process

Location: 7.0,

Perform final accounting at the output granule (scene) level. Create the granule header. Update or generate the metadata items. Transmit the data to the PMS. Deallocate memory and disc stores.

Determine Data Quality

Type: Data Process

Location: 6.5,

Derive any data quality indications for both the post processing record and the Metadata (and headers).

Determine Granule Completeness

Type: Data Process

Location: 7.1,

Determines if an output granule (scene) has been completed. If so, pass the granule to further processing. If not, indicate to the control processes that more data needs to be processed.

Determine Ground Location

Type: Data Process

Location: 5.0,

Determine the ground anchor points and append this data to the output granule.

Determine Memory Requirements

Type: Data Process

Location: 2.2,

Calculate the memory and disk size requirements, knowing the processing mode, number of output granules, or other parameters.

Determine Scan Vector Direction

Type: Data Process

Location: 5.2,

Using the spacecraft attitude and instrument geometry, determine the look angles for each anchor point. This includes instrument attitude corrections such as tilt, scan mirror velocities, and detector geometry.

Determine Termination Type

Type: Control Transform

Location: 7.6,

Derive the abort or graceful termination type.

Dynamic Status

Type: Control Flow

Location: 1.0, 7.0

The request for and returning of dynamic status information.

Dynamic Status Request

Type: Control Flow

Location: 1.1, 7.1

A message originating via the SCA requesting that current processing information be posted into a return message. See Dynamic Status Response.

Dynamic Status Response

Type: Control Flow

Location: 7.1, 1.4

An internally generated message to be sent to the SCA that indicates the current status (accounting) of the data processing task. See also Dynamic Status Request.

Earth Model

Type: Data Store

Location: 5.4,

The description of the Earth ellipsoid.

Ellipsoid Parameters

Type: Data Flow

Location: Earth Model, 5.4

The parameters used in the Earth ellipsoid model

Event, Anchor Points

Type: Control Flow

Location: 5.0, 1.4

An anomaly has occurred in the calculation of the anchor points. This may indicate an off Earth point, Moon looking point, illegal point, or a numerical problem.

Event, Instrument

Type: Control Flow

Location: 4.3, 1.4

An indication that an instrument event has been detected with a description of that event.

Find Intersection with Earth

Type: Data Process

Location: 5.3,

Perform an analytical computation to determine the intersection of the scan pointing vector and the Earth ellipsoid. Determine if this intersection exists. Also determine if this is a Moon looking scan. This is still in the inertial coordinate system.

Find Intersection with Moon

Type: Data Process

Location: 5.6,

Calculate the intersection of the scan vector with the Moon. Set the Land Sea Moon Space flag accordingly. Pixels looking at the Moon can be used for calibration and scan angles at the Moon boundaries can be used for attitude correction.

Find Moon Intersection

Type: Data Process

Location: 5.6.2,

Compute the intersection of the anchor point scan vector and an enlarged Moon. Determine if this intersection exists.

Find Two Intersection Points

Type: Data Process

Location: 5.4.2,

Compute the locations of the two intersecting points between the scan vector and the elliptical Earth.

Finished Granule

Type: Control Flow

Location: 7.1, 7.2

An indication that a granule of output data has been completed.

Geographic Location

Type: Data Flow

Location: 5.3, 5.4

The locations in Earth coordinates of the intersections of the IFOV scan vectors and the Earth ellipsoid surface.

Get Attitude Deviations

Type: External Entity

Location: 5.3,

A process (currently external) that returns the small attitude corrections required to correct the attitude accuracy to an attitude knowledge specification. This may consist of platform and instrument deformations, and ground control point corrections.

Get Moon Parameters

Type: External Entity

Location: 5.6,

A routine that returns the position and size of the Moon given a UTC time.

Get Platform Location

Type: Data Process

Location: 5.1,

Obtain the spacecraft location and attitude in the inertial coordinate system coincident with the time of each ground anchor point scan. This includes MODIS platform offsets, thermal deformations, and oscillations due to other instruments.

Get Terrain Elevation

Type: External Entity

Location: 5.4,

Returns the elevation of the Earth surface at the specified Earth location. This elevation is referenced to the Earth oblate ellipsoid.

Graceful Termination

Type: Control Flow

Location: 7.6, 7.1

An indication to perform a graceful, post data and update metadata, termination.

Granule and Metadata

Type: Data Flow

Location: 7.3, 7.4

The fully completed Level-1B data granule (scene) and its Metadata.

Granule Data

Type: Data Flow

Location: Granule Structure, 7.1

The data contained within the granule.

Granule Incomplete

Type: Control Flow

Location: 7.1, 1.0

An indication that a data granule is not complete and more data is needed.

Granule Initialization

Type: Data Flow

Location: 3.1, Granule Structure

Data values that initialize the internal granule store area to invalid data indicators.

Granule Location

Type: Data Flow

Location: 2.3, 2.4

The memory addresses and file names of the data stores.

Granule Outline

Type: Data Flow

Location: 2.4, Granule Structure

Address, sizes and types of the MODIS Level-1B granule store area. Initialization does not occur here.

Granule Structure

Type: Data Store

Location: 2.0, 3.0, 4.0, 5.0, 6.0, 7.0

The storage area for the data set granule (scene) containing a header with metadata values and instrument science and engineering data. Ancillary data such as calibration coefficients is also included.

Granule With Header

Type: Data Flow

Location: 7.3, Granule Structure

The data granule (scene) with header information attached.

Indicate a Changing Tilt State

Type: Data Process

Location: 5.2.5,

Set the anchor point location values to a flag condition that indicates that ground locations can not be calculated due to a changing tilt angle.

Initialization Complete

Type: Control Flow

Location: 3.1, 4.1

An indication that the output granule (scene) store has been initialized with invalid data indicators.

Initialization OK

Type: Control Flow

Location: 3.1, 3.2, 4.1

An indication that the internal granule storage area has been initialized with invalid data indicators.

Initialize Granule

Type: Control Flow

Location: 3.2, 3.1

An indication to place the invalid data indicators into the output granule (scene) store.

Initialize Output Granule

Type: Data Process

Location: 3.0,

Place invalid value indications into the output granule (scene) storage area in preparation for the next granule processing.

Initiate Termination

Type: Control Flow

Location: 1.1, 1.3

An indicator to begin program execution termination. This may be either an abort-now (close files, deallocate memory) or graceful termination (post data before abort).

Input

Type: Data Flow

Location: Context Diagram,

Consists of: Level-1A data or quick-look and locally maintained databases. (S/C ancillary data is included in the Level-1A data at this time.)

Interpolate Platform Ephm & Att.

Type: Data Process

Location: 5.1.1,

Using the aligned data, interpolate the platform ephemeris and attitude for each ground anchor point.

Interpolated Ephemeris & Att.

Type: Data Flow

Location: 5.1, 5.2

The spacecraft platform ephemeris and attitude and the time of the ground anchor points.

Level-1B Granule

Type: Data Flow

Location: Granule Structure, 7.4

The final processed MODIS Level-1B data granule.

Log Entry

Type: Data Flow

Location: 1.2, 1.3, 1.4, Processing Log

A record to be posted in the EOSDIS (or other) master Processing Log. This provides an audit trail.

Memory Allocation

Type: External Entity

Location: ,

An operating system memory (and disk) allocation routine. A process requests storage allocation and the system returns error or location parameters.

Memory Requirements

Type: Data Flow

Location: 2.2, 2.3

The derived size of the Level-1B storage areas needed to process the output granules (scenes) of data.

Metadata Items

Type: Data Flow

Location: Metadata Structure, 7.3

The items in the Metadata structure that are updated or derived in this MODIS Level-1B program.

Metadata Outline

Type: Data Flow

Location: 2.4, Metadata Structure

Addresses, sizes, and types of the metadata store allocation. This sets up the metadata memory area and initializes that area with Level-1A metadata values and additional predefined values representing invalid data.

Metadata Structure

Type: Data Store

Location: 2.0, 7.0,

The storage area for the MODIS Level-1B metadata values.

Metadata Updated

Type: Control Flow

Location: 7.2, 7.3

An indication that the Metadata has been successfully updated.

Modified Ellipsoid

Type: Data Flow

Location: 5.4, 5.3

A modification to the size of the Earth oblate ellipsoid to correct for the terrain elevation at an IFOV point.

Modify and Append Metadata

Type: Data Process

Location: 7.2,

Update any Metadata items and derive any new ones. This are placed into the enlarged Metadata store.

MODIS Locations and Attitudes

Type: Data Flow

Location: 5.1.2, 5.1.3

The anchor point data within the scan cube which has been corrected for the MODIS platform location and relative attitude.

MODIS-1B Product Generation

Type: Data Process

Location: Context Diagram,

The processor of MODIS Level-1A data products into MODIS Level-1B data products.

Moon Anchor Point Flags

Type: Data Flow

Location: 5.6.3, 5.6.4

The flags to be placed into the anchor point lat-long locations indicating a Moon or off-Earth intersection.

Moon Intersection Points

Type: Data Flow

Location: 5.6.2, 5.6.3

The two points of intersection of the MODIS scan vector and the moon pseudo-surface, or an indication that an intersection does not exist.

Moon Location

Type: Data Flow

Location: 5.6.1, 5.6.2

The location of the Moon and its "zone of intersection" (size) in the inertial coordinate system.

Moon Looking Scan Cube Number

Type: Data Flow

Location: 5.6.4, Metadata Structure

An annotation to be placed in the metadata that indicator which scan cubes in this granule have Moon looking pixels.

Moon Orbital Parameters

Type: Data Flow

Location: Get Moon Position, 5.6

Given the UTC time, return the position and size of the moon at the specified time.

Nearest Point

Type: Data Flow

Location: 5.4.3, 5.4.4

The scan vector to Earth intersection point that is nearest to the satellite, in the inertial coordinate system.

Next Data

Type: Control Flow

Location: 3.2, 4.1

An indication that the MODIS Level-1B program is ready for the next quantum of input data.

Off-Earth Location

Type: Data Flow

Location: 5.3, 5.6

Scan vectors that are not pointing at the Earth.

OK Target Values

Type: Data Flow

Location: 6.2, 6.3

Data values that may be used for calibration that have passed quality checks. This includes bounds and other sanity checks.

Output

Type: Data Flow

Location: Context Diagram,

Consists of Level-1B products, Processing Log entries, Metadata, Browse data, and/or quick-look products.

Output Products

Type: Data Flow

Location: 7.4, PMS

MODIS Level-1B Products consisting of the data granules (scenes), enlarged Metadata, and Browse data. The products may be standard, reprocessed, or quick-look. The products can be either file names or file contents.

Place Invalid Indicators

Type: Data Process

Location: 3.1,

Put invalid data value indicators into the predefined output granule (scene) store in computer memory. This provides an indication of granule completeness in the data granule without accessing the Metadata.

Platform Locations

Type: Data Flow

Location: 5.1.1, 5.1.2

The interpolated platform location and attitude for each anchor point appended to the aligned scan cube data.

PMS

Type: External Entity

Location: 7.0,

Product Management System. Performs management of processed data, adds further data quality (metadata) information before passing the data to the DADS.

Post Anchor Point Locations

Type: Data Process

Location: 5.5,

Convert from inertial to Lat-Long coordinate system and post the anchor point data to the output granule (scene). Determine the solar and satellite, azimuth and elevation angles and append these to the output granule.

Problem, Calibration

Type: Control Flow

Location: 6.2, 6.3, 1.4

An alarm indicating a serious problem in the calibration of the instrument. This may be a loss of calibration parameters, numerical problems, or out of bounds condition.

Problem, Data

Type: Control Flow

Location: 4.1, 1.4

An alarm that indicates that invalid MODIS Level-1A data has been received from the DADS.

Problems and Events

Type: Control Flow

Location: 4.1, 4.3, 1.4

Any alarms or events that are to be detected at this Level-1B processing. This is probably a duplicate of the processing in the Level-1A program.

Problems, Initialization

Type: Control Flow

Location: 2.1, 1.4

An alarm message indication that a serious problem has occurred in the initialization of required store areas. This could be computer memory or disk memory.

Process Control

Type: Control Flow

Location: Context Diagram,

The SCA control of the initialization, dynamic status requesting, and termination of this program.

Process Control

Type: Control Transform

Location: 1.0,

Handles the control functions of this program. Accepts and sends control information to/from the SCA.

Process Status

Type: Control Flow

Location: Context Diagram,

The interface with the SCA consisting of Post Processing Status, Dynamic Status Response, Alarms, and Events.

Processing Log

Type: External Entity

Location: 1.0,

Log of processing status records, time sequential events.
This is not the current status, but a time based history
of status events.

Processing Mode

Type: Control Flow

Location: 1.2, 2.2

The mode of processing (standard, reprocessing, quick-
look) with any size parameters required.

Processing Status Information

Type: Control Flow

Location: 1.4, SCA

Information regarding the fault conditions and processing
performance of this program. Status or completion
information from the MODIS process to the SCA with
abnormal, dynamic, or normal termination information.

Replace Raw with Calibrated Data

Type: Data Process

Location: 6.4,

Place the calibrated data values into the proper output
granule (scene) location.

Request Memory

Type: Data Process

Location: 2.3,

Ask the operating system for system resources to allow the
processing of this data set. This includes both computer
memory and disk memory.

SCA

Type: External Entity

Location: 1.0,

Schedule, Control, and Accounting. An EOSDIS core system
process that performs scheduling, control, and accounting
of the various Product Generation System (PGS) programs.

Scan Times

Type: Data Flow

Location: Anchor Scan Times, 5.1

The time offsets for each anchor point within the
instrument scan.

Scan Vector

Type: Data Flow

Location: 5.2.4, 5.3

The pointing direction of the instrument field of view (IFOV) at the selected anchor point scan positions. This has been corrected for the detector physical positions.

Select Closest Point

Type: Data Process

Location: 5.4.3,

Select the scan vector to Earth intersecting point that is closest to the satellite.

Set Special Anchor Points

Type: Data Process

Location: 5.6.3,

If a Moon intersection has been found, set the corresponding anchor point to a special flag value. Set this anchor point to the off-Earth value otherwise.

Setup Data Output Structures

Type: Data Process

Location: 2.0,

Setup the memory areas and the Output Data Product areas in computer memory and disk. Preallocate these data and metadata areas.

Setup MODIS Data Stores

Type: Data Process

Location: 2.4,

Determine all data stores. Initialize the "yet to be determined" Metadata items to an invalid condition.

Setup Processing Mode

Type: Control Transform

Location: ,

Derives the mode parameters, posts an entry to the system Processing Log, and starts the show.

Stable Tilt

Type: Data Flow

Location: 5.2.1, 5.2.2

An indication that the tilt angle has not changed since the last scan cube was processed.

Start

Type: Control Flow

Location: 1.2, 2.1

An indication to start the processing of MODIS Level-1B data.

Start Process

Type: Control Flow

Location: 1.1, 1.2

The result of an "Initiate processing" message type being passed to this MODIS Level-1B program from the SCA.

Termination

Type: Control Flow

Location: 1.3, 7.6

An indication for the program to terminate immediately (abort) or gracefully (post remaining data). Either termination will cleanup and return any files or memory areas used to the operating system.

Terrain Elevation

Type: Data Flow

Location: Get Terrain Elevation, 5.4

Given an Earth location, return the elevation above the reference ellipsoid.

Test for Imaginary Roots

Type: Data Process

Location: 5.4.1,

Solve for the value of the radical in the scan vector to Earth intersection equation. If this number is negative, then the intersection is off Earth.

Thermal Corrected Attitude

Type: Data Flow

Location: 5.1.3, 5.1.4

The anchor point data within the scan cube that has been corrected for and platform thermal deformations.

Thermal Correction

Type: Data Flow

Location: Thermal Data, 5.1.3

The parameters for the conversion from engineering counts to temperatures.

Thermal Data

Type: Data Store

Location: 5.1.3,

Parameters for converting engineering data to temperatures.

Tilt in Progress

Type: Data Flow

Location: 5.2.1, 5.2.2

The MODIS-T instrument has changed the tilt angle since the previous cube has been processed.

Tilt Values

Type: Data Flow

Location: 5.2.5, Metadata Structure

Instrument tilt values for metadata purposes such as minimum and maximum tilts, tilt intervals, and percentage of data at each tilt angle.

Tilted Attitude

Type: Data Flow

Location: 5.2.2, 5.2.3

The scan cube with the interpolated positions and attitudes corrected for any MODIS-T tile angles.

Transform to Detector Points

Type: Data Process

Location: 5.2.4,

Transform the anchor point attitudes to the detector positions for each anchor point field of view.

Transmission Complete

Type: Control Flow

Location: 7.4, 1.0

An indication that the Level-1B data products have been transmitted to the PMS.

Transmit Data Products

Type: Data Process

Location: 7.4,

Transmit the Level-1B data products by either file name or records to the PMS

Two Intersecting Points

Type: Data Flow

Location: 5.4.2, 5.4.3

The intersections of the scan vector and the Earth ellipsoid.

Unpack Data

Type: Data Process

Location: 4.2,

Unpack the 12 bits plus scaling bit into a computer recognizable data type. This is to be performed in place to minimize store area sizes.

Unpacked Data

Type: Data Flow

Location: 4.2, 4.3

The input data quantum in an unpacked (byte aligned) form.

Updated Metadata

Type: Data Flow

Location: 7.2, Metadata Structure

Items from the previous Level-1A Metadata that are to be updated and any new Metadata items for Level-1B.

Verified Data

Type: Data Flow

Location: 4.1, 4.2

A MODIS Level-1A data quantum that has passed verification checks.

Verify Data Quantum

Type: Data Process

Location: 4.1,

Ask for a quantum of MODIS Level-1A data and verify that a piece of valid data has been received. Generate a problem alarm if invalid data has been detected.

Verify Selected Data

Type: Data Process

Location: 4.3,

Perform any data value integrity tests. This may include items not visited in the Level-1A program in addition to newer items as defined during this processing level.